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Twelve Years' Progress in Weather Forecasting

THE appearance of a second edition of Sir Napier Shaw's *Forecasting Weather* will be cordially welcomed. The first edition has been out of print for some time, and the dozen years which have elapsed since its appearance, in 1911, have been eventful ones in the domain of meteorology as in other departments of human activity. They have all but revolutionised the practice of the daily weather services of European countries. Even those who have been in close touch with each successive development in the method of collecting and presenting the facts for the daily conspectus of weather information represented by the Daily Weather Report of the Meteorological Office will perhaps be astonished at the magnitude of the changes when they have the whole story set out as it is in the opening chapters of this book. We think that the author was well advised in retaining in the new edition the description of the Daily Weather Report of the year 1910, itself a record of rapid changes of form which the report had undergone in the years immediately preceding the appearance of the first edition, and adding to it an account of the changes which have increased the report from one setting out some 2,000 facts about a day's weather in north-west Europe to one in which about 8,000 facts are marshalled for the information of the reader. The contrast will be of absorbing interest to the non-professional reader and should give the professional meteorologist furiously to think on how he can digest and turn to advantage the almost bewildering mass of information presented.

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Other changes which have taken place in the domain of organisation are concerned with the units used for meteorological measurements. In the first edition the author was clearly much exercised over this question. His aim, which as Director of the British Weather Service and President of the International Meteorological Committee he was in a unique position for futhering, was to bring about the general adoption of a system of units based on the C.G.S. system. The extent to which that ideal has been realised in the intervening years is detailed in the book. It is a record of mixed achievement and failure. The millibar has made substantial progress as the unit for the measurement of pressure and is rapidly gaining ground in all that pertains to the study of the upper air. Measurements of rainfall are now published in millimetres in the Daily Reports of this country. In other respects there has been little progress, and the author has sorrowfully to admit that the adoption of the tercentesimal scale of temperature in place of the Fahrenheit scale seems further off now than it did a few years ago.

Among the additions to the book we notice with pleasure the chapter on clouds necessitated by the inclusion of type and amount of high and low cloud among the facts which observers are expected to report in their messages. In the main it is an account of the international classification of cloud forms, but it is presented in a manner which cannot fail to impress on the reader the importance of keeping in mind the physical processes involved in the formation of clouds, and the illustrations, though on a small scale, are not only beautiful in themselves but are extraordinarily well selected from that point of view.

The same insistence on physical causes which the author has had so prominently before him in the whole conception of the book, has led him to give considerable space in the new matter now introduced to the question of turbulent motion. The conception has only found its way into meteorological literature, thanks to the researches of G. I. Taylor and others, within the period which has elapsed since the first edition appeared. It has cleared our ideas to a remarkable extent on the processes underlying the formation of fogs and of some forms of clouds, and the reader will find a clear exposition of the principles involved, and some suggestions for their application in the domain of forecasting the occurrence and development of these meteors. Space is also found for consideration of the problems of visibility which have come into prominence in recent years, and for an exposition of the theory of the polar front which we owe to the labours of the Norwegian school of meteorologists and which has already had its influence on the practice of forecasting.

Taken as a whole a comparison of the two editions leaves on the mind the impression of a prodigious advance in the organisation for the collection and distribution of weather information, but that, as the author points out, represents progress in communications rather than in forecasting proper. On the other hand we get a sense of the very real progress which the science of meteorology has made in the last twelve years in the matter of understanding the processes going on in the atmosphere, on which the changes in our weather which we experience from day to day depend. Let the reader go through the book and note the passages which could not have been written twelve years ago, for the reason that our knowledge was not sufficiently far advanced, and he will realise that meteorology is not standing still. A forecaster equipped only with the knowledge available in 1911 would stand but a poor chance of turning to profitable account the additional material now at his disposal, but the application of the new knowledge to the task of forecasting the weather day by day has hardly yet begun, above all the application of methods of numerical computation such as those suggested by L. F. Richardson which are briefly described in the book is still far off.

In conclusion we should like to congratulate Messrs. Constable and Co. on the manner in which they have accomplished the task of presenting the book and its numerous illustrations. We wish they could have seen their way to producing it at a lower cost. The increase from twelve shillings and six pence to thirty six shillings is considerable, but presumably in these days it is truer than ever that if we want a good thing we must be prepared to pay for it.

R.G.K.L.

The Great Earthquake in Japan

How the Meteorologists Fared

By the courtesy of Sir Napier Shaw we are able to give the following extracts from a letter written to him by Dr. Fujiwhara after the great earthquake and fire which occurred in Japan on September 2nd.

> As you know, Tokyo, Yokohama and their vicinity experienced a terrible catastrophe. The area of the destructive motion of the earth was about one degree square (about 10,000 sq. km.). Nearly 120,000 people were killed. . . . . The number of houses burnt in Tokyo was about 320,000 and the number of sufferers about 1,350,000. . . . . I was making an experiment upon water vortices with an assistant when the first shock was felt at 11h 58m. 44s. The water in the tank was thrown out and I felt vexed at the unexpected disturbance in the experiment. But very soon I recognised the earthquake was heavy, and the circumstance was imminent. I bade my assistant not to go out, but to crouch down on one side of a firm stone stand.

I observed that shocks after shocks continued, and plaster fell off from the wall : the wooden skeleton of the wall appeared, which creaked heavily and strained, and I expected that the upper floor would fall down over us, but fortunately it did not, and after about one minute I recognised the principal danger had passed away. We dashed out of the room, and saw that people were still swaying about in the gallery in air smoky with the powder of fallen walls. . . . . The daughter of Professor Okada had given birth to her baby girl on the noon of the preceding day. Of course she was in bed, and the family could not escape without her. All the family then remained still surrounding the bed until Professor Okada and other gentlemen ran back for the rescue. They carried out the bed with her and made a tent there. Mrs. Okada was so brave and calm, and quite composedly gave orders to the nurse and maid how to act. Afterwards when the fire was near she asked Professor Okada not to care for his home, but to take duty at the Observatory, so that not only he, but also other members of the Observatory could fight against the fire. . . . . During this time the wind blew from the south-west, and our Observatory was rather safe. From 8h. in the evening the wind shifted to the west, and then to the north-north-west, and sparks began to arrive. At this time Tokyo was filled with dark smoke and brilliant flame, and many thousands of refugees assembled in the vicinity and prevented our work. Firemen were busy and tired, and could not come to our Observatory. The waterworks had been broken by the first shock and we could not get water, except from the bathing tubs, which I had ordered to be filled up in anticipation. Thus the circumstance was very hard for us. Still there was hope, because our Observatory was standing separately from other buildings, and there was a bank with trees protecting it . . . . . Smoke was thick and sparks were furious. One of my comrades got a spark on his back and the cloth took flame. . . . . I determined my mind and descended from the roof, plunged into the people and shouted to them to escape through the Imperial gate, which was thought so sacred, that even in this state people did not dare to go in. A few policemen also echoed my words, and the Imperial Guard let the refugees in. I led my family to the old Observatory through another heavy crowd, and went back to the Observatory and continued the work to prevent fire. . . . . Our comrades took out important books, etc., from the Observatory, and put them into holes, dug in the ground. . . . . In this way, three spots with flame were prevented, but at last the eaves of the roof caught fire, owing to a spark carried by a current which made a vortex there. It was beyond my power, because the water was used up, and moreover I could not approach there, and, after only one minute, flame caught the ceiling. . . . . We had a small library in the main building which was wooden. In this library we kept all new books of meteorology and allied subjects. We tried to save them, but unfortunately heavy book-shelves had tumbled down during the earthquake, and there was no means to take the books out before the library was burnt. . . . . We succeeded in saving the big library, which was built separately with steel concrete. It was full of meteorological data of Japan and foreign countries, old books, etc. . . . . When flame was curling round the library, Mr. Miara, the assistant observer, found that flame streamed in through the wind holes leading under the floor. He put a wet towel over his head and face and closed the holes. By this brave act the library was saved. . . . . I think it would be worth reporting

that our brave observers continued the hourly observations during the fire. No single observation was lost. Air temperature rose 6 to 8 degrees Centigrade above the value otherwise expected. . . . . Tornadoes were reported to have occurred. It seems to be true. Somebody told me that at Hifukusyo—in Tokyo—where more than 30,000 people were killed, a terrible tornado had happened and even a wagon was sucked up. Pine trees were uprooted, and some were twisted off and thrown down. . . . . At that time my sister who lives at Yokohama and had been compelled to take refuge in the river, observed tornadoes here and there. They were whirling up very near the most brilliant fires. She could not remember if they were turning to the right or left, but it seems certain to her that they moved when their fires decayed and joined to the other fire. . . . . Thus it seems certain that tornadoes can be caused by strong heating of the air. . . . . The task to get food continued some 10 days. We lived only by taking rice balls the first few days. On the other hand this was the typhoon season, and the storm warning was absolutely necessary. I issued a weather forecast for the 3rd, only by taking cloud, wind and barometer at Tokyo into consideration. During a week I lost 2 and got 5 hits. We made all efforts to get weather telegrams, and on the 10th we succeeded by erecting a receiving set of radio telegraphy in our Observatory.

We wish to offer our sympathy to Prof. Okada and his staff for the loss they have sustained, and to congratulate them on their escape.

We understand that steps are being taken to send out from this country sets of books to replace some of those lost by scientific institutes in Japan. The original records which have been destroyed are however irreplaceable.

Discussions at the Meteorological Office

November 12th, 1923. *Klimatische Kontinentalität und Ozeanität.* By Prof. R. Spitaler (Gotha: Petermanns Mitteilungen, Vol. 68, June 1922, p. 113). *Opener*—Mr. L. C. W. Bonacina.

In the maps which were the subject of this discussion the lines of equal continentality are based upon the normal difference of temperature between January and July. The fact that the normal distribution of temperature over the globe at any time of the year is determined in the main by latitude, altitude and continentality is expressed by Spitaler in a certain formula. From this formula the annual range, which there would have been at a point had the parallel of latitude containing it been in the middle of a land hemisphere or water hemisphere, can be computed. Comparison of the actual range with these hypothetical ranges affords a measure of thermal continentality. In consequence of the circulation of the atmosphere, whereby

prevailing oceanic winds in one region may transfer oceanity landwards, and continental winds in another may transfer continentality seawards, the thermal or climatic continentality of a place does not always correspond with local geographic continentality as given by the percentage of land around it, but may be overweighted or underweighted with respect thereto. Thus England's climatic continentality is, in consequence of the prevailing Atlantic winds, only 25 per cent., and therefore much lower than its geographic continentality. If geographic continentality be defined, for instance, by the proportion of land in a circle with radius 10°, then for London the value is about 50 per cent.

Mr. Bonacina suggested that continentality should also be studied with reference to diurnal range of temperature, and to the magnitude of irregular deviations from the normal; although these two measures would run roughly parallel with the annual range studied by Spitaler there would be some important discrepancies between the three. He thought that, if some method could be found whereby each locality was assigned a set of continentality co-efficients for the different types of weather, light would be shed on some of the profoundest problems in meteorology.

November 6th, 1923. *The Earth and the Sun. An hypothesis of weather and sunspots.* By Ellsworth Huntington (Yale University Press, New Haven, 1923). *Opener*—Dr. C. Chree, F.R.S.

Professor Huntington has written a book which invites the attention of the general reader looking for the latest teaching on the way that solar changes influence terrestrial weather.

The trend of the discussion suggested that much of the evidence adduced in favor of definite connections between the two would break down under cross-examination. How much of the story of the intrigues of planets and sunspots, radiation and temperature, would survive the cross-examination is not clear. The time is hardly ripe for a judicial summing-up of the case.

The wireless direction-finding apparatus installed at Croydon and Pulham has proved of great service during the recent periods of fog and mist; *e.g.*, the only air express to reach Croydon on November 21st was guided to the aerodrome over the mist and fog in southern England by wireless telephony.

An advertisement of a rain-gauge for sale, second-hand, will be found on page ii. of the cover of this magazine.

Royal Meteorological Society

THE monthly meeting of the society was held on Wednesday, November 21st, at 49, Cromwell Road, South Kensington, Dr. C. Chree, F.R.S., President, in the Chair.

L. F. Richardson, B.A., F.Inst.P.—Attempts to measure air temperature by shooting spheres upward.

Mr. L. F. Richardson is furthering the biblical prophecy*: if he has not literally turned swords into ploughshares he has made guns serve the purposes of the peaceful meteorologist. Mr. Richardson's method of finding the strength of the wind aloft is to fire a spherical projectile upwards, nearly but not quite vertically, and to note what slope must be given to the gun so that the wind may blow the projectile back to the observer's shelter. Incidentally Mr. Richardson noticed that the time of flight of the projectile must depend on the temperature of the air aloft. Considerable refinement in the timing is necessary, but it appears that the average temperature of the air below 300 ft. can be estimated with a probable error of about a degree centigrade. Frequently, and especially in foggy weather, temperature near the ground differs widely from the temperature in the free atmosphere, and a means of determining the latter may prove of great value. We are reminded that the American practice of utilizing for the daily weather service temperatures observed on the roofs of high buildings rather than on the ground has its advantages.

Col. H. G. Lyons, F.R.S.—Exhibit of a replica of an early Korean rain-gauge.

Illustrations of a Korean rain-gauge are to be found in several meteorological works. Col. Lyons has secured for the Science Museum a replica of one of these gauges. The pattern was in use in 1770. It is clear that the importance of a deep gauge and of a good stiff circular rim were appreciated in Korea at that early date. The original might even satisfy such a test as Mr. Heath Robinson would delight to illustrate—gauge on side, observer standing on rim, inspector declaring distortion infinitesimal.

F. J. W. Whipple, M.A., F.Inst.P.—Exhibit of a limit-gauge for rainfall.

Readers of the *Meteorological Magazine* are familiar with the commercial importance of insurance against rainfall. Many insurance policies provide for payment of a claim when the amount of rain recorded is equal to or exceeds 0·10 inch. Mr Whipple showed a measure designed to stand inside an ordinary rain-gauge and to show with precision the limit 0·095, so that falls to be reckoned as 0·10 or more may be easily distinguished from falls to be reckoned as 0·09 or less.

* *Isaiah* ii. 4; *Micah* iv. 3.

S. N. Sen, M.Sc., A.Inst.P.—On the distribution of air density over the globe.

The distribution of the mass of the atmosphere in height as well as in geographical position is a subject of philosophical and practical importance. Mr. Sen has gone through the lengthy process of computing the density of the air from standard estimates of the temperature and pressure, and has presented his results in a series of instructive charts and diagrams. The outstanding peculiarity of the distribution is the fact that in the lower atmosphere the warmer air is the lighter, whilst at greater heights the warmer air is the heavier. The explanation is simple: the expansion of the lower air increases the mass of air to be accommodated in the upper layers. The transition occurs at about 8 kilometres from the ground. As was mentioned in the discussion it is more than a coincidence that 8 kilometres is the average "height of the homogeneous atmosphere."

Correspondence

To the Editor, *The Meteorological Magazine*

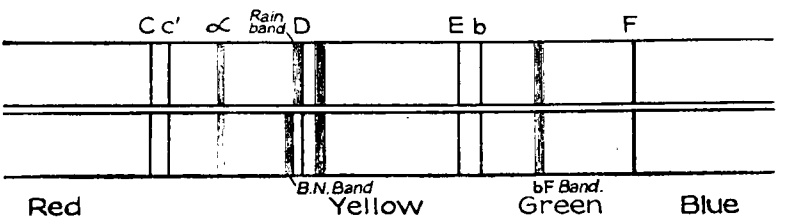
Telluric Spectroscopy

PROFESSOR PIAZZI SMYTH, Astronomer Royal for Scotland, about the middle of last century was the first to draw the attention of scientists to the absorption of light by the aqueous vapour in our atmosphere as shown in the spectroscope. Particularly he pointed out the importance of the telluric absorption band at and near the sodium line D in the solar spectrum as an index to the amount of aqueous vapour present at any time in the atmosphere around and over the point of observation; and from the variations taking place in the intensity of this band the possibility of predicting fine or rainy weather. When the band was but faintly observed fine weather would probably follow, and when very pronounced rain was sure to follow. This band is what is now known to the meteorologist as the rainband.

In 1882, I was initiated into the making of observations of the rainband by Mr. C. L. Wragge, the pioneer in the meteorological work that resulted in the establishment of the Ben Nevis Observatory. During the whole existence of this institution I was one of the staff, and during the first three years I was always on day duty. In this way I was enabled to make hourly observations from before sunrise till after sunset. I always observed every telluric line or band in my field of view from A to F. The lines below C, however, could not be seen except at sunrise and sunset. I kept a record of the varying intensities of the follow-

ing bands, viz.: C′, alpha, rainband, low-sun band, and another band between *b* and F. (See *Madeira Meteorologica* by Piazzi Smyth). After some time I became familiar with my field of view and could detect the slightest variation in the intensity of any of these bands. All my observations made on Ben Nevis are now in the archives of the Scottish Meteorological Society. Following Dr. H. R. Mill and a number of other British and North American observers, I published in the *Scottish Meteorological Journal* and in *Nature* the results of my observations, showing the forecasting value of the rainband spectroscope. Hitherto I have not written anything about the other lines or bands.

In the course of my observations of the bands I have already mentioned, I by-and-by became aware of another band that occasionally made its appearance immediately to the red side of the rainband. This band I observed at its strongest in the evening, after sunset, and just before cold weather. Not knowing more about it we called it the " Cold Band." Now, however, I always call it the " Ben Nevis Band." After a bit I included this band in the general routine of observation, noting its presence and intensity or its absence as the case might be. It was some years after I had first noted the " Ben Nevis band " that I came to associate it with variations in the rainband. This was on the summit of Ben Nevis ; but as it was not infrequent to observe the rainband diminish in the evening, owing to the damp air falling below the level of the summit, I did not give much weight to the fact that as a rule when the " Ben Nevis band " increased the rainband diminished. At sea-level at Fort William there was always a fair amount of rainband, so I could not there detect the connection.



THE SOLAR SPECTRUM

After the closure of the Ben Nevis Observatories I had the honour to be appointed to the staff of the Meteorological Office of the Argentine Republic, under Director Davis. At first I had a spell down south on the staff of the observatory in the South Orkneys. There I observed the relation between the " Ben Nevis band " and the rainband, just as I had observed it on Ben Nevis. There could have been no sinking of the damp air at the South Orkneys, for observations were made at sea-

level, so I was forced to the conclusion that the increase in the "Ben Nevis band" was due to the decrease in the rainband—that the increase in the former was at the expense of the latter.

On settling down here in Buenos Aires, I was surprised to see the "Ben Nevis band" fairly strong at times in this latitude and at sea-level. I have never seen the matter so pronounced, however, as during a recent intense spell of drought. Some evenings the "Ben Nevis band" was as strong as the alpha band, and spectroscopists know what that means; while the D line showed as a very clear, clean but weak line with a trace of the yellow part of the spectrum on its red side. I had never observed the like of this before.

So far, I have never found myself equipped with the means and instruments to enable me to say what the gas or vapour is that causes the "Ben Nevis band." I only know that it appears and behaves in relation to the rainband as I have already described.

ANGUS RANKIN.

Oficina Meteorologica Argentina, Buenos Aires, August 2nd, 1923.

[Mr. Rankin is to be thanked for calling attention to the utility of spectroscopic observations for indicating the changes in amount of vapour in the atmosphere. The pioneer work of Piazzi Smyth has not been followed by the development of a routine in which the personal equation of the observer is eliminated and quantitative results are obtained. Variations in the absorption of the ultra-red rays have been studied at the Solar Physics Observatory on Mount Wilson, and a paper by Fowle shows how the proportion of vapour in the free atmosphere can be estimated and compared with that in the air at the observatory.—ED. *M.M.*]

The Burning of Ferne doth draw downe Rain

IN an old book entitled "Choice Notes from 'Notes and Queries'" there is the following interesting extract, being a letter written by Philip Herbert, third Earl of Pembroke, Lord Chamberlain to the Sheriff of Staffordshire, which illustrates a curious popular belief somewhat akin to the idea that gunfire brings rain.

> "Sr. His Majesty taking notice of an opinion entertained in Staffordshire, that the burning of Ferne doth draw downe rain, and being desirous that the country and himself may enjoy fair weather as long as he remains in those parts, His Majesty hath commanded me to write unto you to cause

all burning of Ferne to bee forborne untill His Majesty be passed the country. Wherein not doubting but the consideration of their own interest as well as of his Majesty's will invite the country to a ready observance of this his Majesty's command, I rest

Your very loving friend,

PEMBROKE AND MONTGOMERY.

Belvoir, 1st August, 1636.

To my very loving friend the High Sheriff of the County of Stafford."

Unfortunately there is no record of the weather during the King's visit.

CICELY M. BOTLEY.

10, Wellington Road, Hastings, October 20th, 1923.

Variability of Climates

MY attention has been called by a member of the Cornwall Rainfall Association to a statement in an article on p. 158 of your August number that the percentage range of mean monthly rainfall is under 10% in 65 per cent. of the area of Europe, and no part has over 30%.

I find on referring to Hellmann's "Untersuchungen über die Schwankungen der Niederschläge" that for the fifty years, 1851—1900, the wettest month throughout Europe generally had nearly three times the rainfall of the driest month in the year, there being very few places where the proportion is as low as twice as much. It would be interesting to know how the figures given in your August number are obtained.

A. PEARSE JENKIN, F.S.I.

Trewirgie, Redruth, October 31st, 1923.

[The interpretation of the statement in question is that in the memoir by Supan on which the map referred to by Dr. Visher is based the normal rainfall of each month is expressed as a percentage of the normal rainfall of the year, and the difference between the falls in the driest and wettest months is likewise expressed as a percentage of the annual fall. For example, at Greenwich :—

The normal for the wettest month has	11·4	per cent. of the annual fall.
The normal for the driest month has	6·0	
The range is	5·4	

Accordingly Greenwich falls in the region with range below 10 per cent.—ED. *M.M.*]

NOTES AND QUERIES

The Norwegian Meteorological Service and Losses in the Arctic

MOST meteorologists are aware of the splendid work being done by Norway in obtaining meteorological information from the Arctic by wireless telegraphy so that it is available for the rest of the world to use on daily synoptic charts; but few probably are aware of the grievous losses both in men and ships that this work has cost the Norwegian people. At the International Meteorological Conference at Utrecht in September, Dr. Hesselberg told us that during last year no less than three men of the Norwegian Meteorological Service lost their lives in the course of their duties in the Arctic, and now another tale of danger and of loss of ships and lives has just come to hand.

In the summer of 1922 a Norwegian hunting expedition crossed from Tromsö to Greenland. The Norwegian Meteorological Office equipped the expedition with a telegraphist and radio set. The expedition reached Mygbugten in its ship "Annie" in the autumn of 1922, and commenced that regular series of weather messages from Greenland which has been so useful in our daily weather work.

For some time past the Norwegian Office has maintained a party of meteorologists equipped with wireless on the island of Jan Mayen, and in July 1923, the ship "Conrad Holmboe" was despatched with provisions and new men for the two stations at Jan Mayen and Mygbugten. All went well until, after completing the work at Jan Mayen, the "Conrad Holmboe" tried to reach Mygbugten, but then she was caught in the floes, and seriously damaged by screw-ice. In the meantime the "Annie" left Mygbugten and nothing more was heard from her. In these circumstances it was necessary to send a relief expedition, and the ship "Polarulv" went to the ice off Greenland. She kept in touch by wireless with the "Conrad Holmboe" and succeeded after the lapse of a month in bringing the damaged ship back to Isafjord in Iceland, little more than a wreck, but with the 14 men on board all safe and sound.

The "Polarulv" then went back again towards Greenland to try to find the "Annie," but she, in her turn, was involved in disaster, for, when between Iceland and Greenland, she foundered during a storm. The captain and three men were drowned, but the rest of the crew were saved by a British trawler. It is now too late in the season to send a new relief expedition to the aid of the "Annie," about which ship and its crew no information has been received since she left Mygbugten.

The British have always admired the men who risk their

lives in polar regions in the cause of science, and our sympathies—especially as meteorologists—go out to Dr. Hesselberg and his colleagues in the Norwegian Meteorological Service in this their time of great anxiety, and we join with them in their hope that the crew of the "Annie" has succeeded in reaching the coast of Greenland.

G. C. SIMPSON.

The Growth of the Daily Weather Map

IT is interesting to note how the area covered by the daily weather maps of the various countries has been extended during the last few years so that observations from the greater part of the northern hemisphere are now plotted each day.

Sir R. F. Stupart in a letter addressed to the President of the Conference of Directors points out that Canada has started to form a network of wireless meteorological stations in northern Canada. Stations at Dawson and Mayo, Yukon, are to be opened immediately, and next spring stations will be placed at Fort Simpson (Lat. 62°, Long. 121°) and Fort McMurray (Lat. 57°, Long. 111°), where the system will connect with the land telegraph. This will cause a further extension of Canada's daily (10h.) working maps, which are already very comprehensive as they extend from Long. 180° across north America and the northern Atlantic to Central Europe, and include Spitzbergen and Gibraltar.

Charts of the weather of the northern hemisphere, showing observations which reach from the west coast of America across the north Atlantic to the western borders of Russia, are issued each day by the Meteorological Office, London, and our knowledge of the weather conditions is extended still further eastwards by the maps of the Russian daily weather reports, which are among the largest to be reproduced for publication. These maps cover the whole of Europe and stretch across western Asia as far as Long. 90° E. The daily weather charts of the North Pacific Ocean which are now being published by the Imperial Marine Observatory, Kobe, complete the circle of observations round the hemisphere. These charts are published monthly and represent the conditions at noon by Japanese Standard Time (3h. G.M.T.). The observations extend over an area from Lat. 5° N to 65° N. and from China and Siam to the United States. The first two volumes containing the maps for January and February, 1923, are now available.

It would be of interest to know what regions are included in the working charts of the United States and Norway. Publication of the charts of the northern hemisphere issued day by day by the United States during the year 1914 has not been resumed.

Atmospheric Electricity from the Engineer's point of view

Dr. ALEXANDER RUSSELL, President of the Institution of Electrical Engineers, delivered his inaugural address on October 18th, 1923. One section of the address was devoted to a consideration of thunderstorms. The exposition of the physics of the phenomena of a thunderstorm was interesting, but a good many of the statements in it would probably be challenged by other workers in this controversial subject.

Amongst the personal experiences mentioned by Dr. Russell was the watching of a thunderstorm at sea from a small boat on a calm day. Where the lightning seemed to strike the sea a narrow column of spray or more probably steam rose suddenly, the effect being similar to that produced by a gannet when diving. Dr. Russell has also had the good fortune to see globular lightning. He was on the coast of Ayr many years ago when two spheres of a dull reddish colour about 20 or 30 feet up moved slowly in from the sea, each about a foot in diameter. One hit the wall of a building but did no apparent damage, although it made a loud report. The other drifted away.

Ball Lightning

SOME interesting accounts of ball lightning have recently been received. These illustrate the excessive variability of the phenomenon.

In one case, investigated by the Rev. H. D. Dale, Vicar of Hythe, the ball lightning occurred during a very heavy hail shower in the evening of April 26th, 1923. No sign of an approaching thunderstorm was observed, but suddenly at 7h. 30m. a ball of fire, which appeared to be about 6 to 12 ins. in diameter, fell and burst almost instantaneously, penetrating the metal road to a depth of 2 ft. 8 ins., then running along the metal water main. This was followed by a tremendous thunderclap. The road immediately after the explosion appeared filled with sparks followed by smoke. Windows were broken in houses 150 to 300 yds. away, and the electric lighting affected in houses half a mile away, while the wire netting on the palings close by fused, and lines were scored on the bark of trees 2 to 8 yds. from the hole, which was about 1½ ins. in diameter.

Another account of ball lightning comes from Mr. J. Mintern, of Killmurry, Passage West, Co. Cork, who reports that he observed ball lightning during a severe thunderstorm on the evening of May 2nd, 1923. The first ball of fire was seen about 21h. 30m.—it was a clear yellow in colour, and its edges were defined. It was visible for a few seconds and then seemed to drop slowly, in the north apparently, into the river Lee. A few minutes later a vivid flash was seen " like a rope of fire coloured

blue, green and yellow." A little later still a second ball of fire was seen to fall more to the eastwards, where the storm was travelling. This ball was not so distinct as the first, and "looked as if seen through a fog." The storm was not associated with heavy rainfall; only a few moderate showers fell while it was at its height.

On another occasion the ball lightning was seen in a church. The *Daily Express* states that the Rev. T. Peacock, Vicar of Hemingborough, was giving an address at Selby to the Yorkshire Association of Bellringers during a thunderstorm on the afternoon of September 2nd, 1923, when a ball of fire appeared in the church, ran up the aisle and then exploded. The air was pungent with the smell of sulphur. One curious thing about the fireball was that it rolled up the carpet in the aisle.

Nature of Ball Lightning

DR. RUSSELL'S address gave Dr. Simpson the text for an article on "Thunderstorms and Globular Lightning" in *Nature* of November 17th. Dr. Simpson's opinion is that "the only physical phenomenon yet produced in a laboratory at all approaching ball lightning is the active nitrogen studied by Lord Rayleigh." On the other hand Mr. E. Kilburn Scott writes to *Nature*, of November 24th, pointing out that in the manufacture of nitrogen products on a large scale, nitric oxide and nitrogen dioxide are formed in the electric arc, and suggests that ball lightning may consist of these substances in a very concentrated and possibly liquid form.

Minimum Thermometers

THE experience of meteorologists with spirit thermometers seems to differ widely from that of other physicists. The meteorologist knows that it happens frequently that a minimum thermometer which obtains a good certificate when first made develops an error in the course of its first year or two of service and reads too low. In many cases the error is temporary, by standing the thermometer so that any spirit on the walls of the tube can drain down to the main body the trouble is cured, but as a general rule it is persistent. This evil which, we understand, is not met with in thermometers used for laboratory purposes, has been explained in various ways; the favourite theory is that alcohol escapes through minute cracks or holes in the glass; another suggestion is that the tubes used for spirit thermometers are not annealed with the same care as those for mercury thermometers, and that the bulbs expand when the air above the spirit exerts its pressure at high temperatures. One maker thinks that in certain conditions the glass would absorb spirit to such an extent as to account

for the observed errors, but nothing definite is known about this process. In 1921 two defective grass minimum thermometers were sent to the National Physical Laboratory for an exhaustive test, and have been under examination there since then.

One thermometer (No. 1368), which had been certified as correct in 1909, required a correction +3·4° F. in 1921, and in 1923 the correction had increased to +3·7° F. With the second (M.O.17148) the corresponding figures were +1·1 and +1·3. It will be noticed that in both cases the zero is still falling.

With a view to obtaining some evidence of the flaw in the glass, the thermometers were kept in an evacuated vessel for some days at the temperature of melting ice, but this test does not show any change in the readings of the instrument. Very careful examination of the thermometers shows no evidence of minute flaws which could lead to a slow leak of the contained spirit; this is confirmed by the negative result of the test in vacuo. It has to be admitted that it is not possible at present to offer an adequate explanation of the phenomena. The two thermometers are still under observation at the Meteorological Office.

Organic Bodies in the Air

THE presence of organisms of various kinds floating in the air is regarded amongst medical men as axiomatic. It is therefore remarkable that until recently very few of such organisms had been identified on the microscope slides made with Dr. Owens's jet apparatus. The first report of the regular occurrence of organic structures on the slides was received from Dr. H. Kimball, who stated that at Washington in August opalescent bodies had been found in large numbers both in records taken on the ground and also in those taken on an aeroplane. It was not long before similar observations were made in England. On October 10th, 1923, a record taken at South Kensington by Mr. G. M. Watson was found to contain two large bodies identical in appearance with some of those in the specimen slide from America. Subsequently, the organisms were found to be more prevalent in the country, at Cheam, than in London. They were usually oval, the long diameter varying between about 5 to 12 μ (1 inch equals 25,000 μ), giants compared with the ordinary dust particle on the microscope slides. Acting on the idea that the particles were probably characteristic of the air of a wet and stormy autumn Dr. Owens examined the spores of the mould which forms on dead leaves, and found that they were identical in appearance, size and shape with those got from the air.

Meteorological Charts

IT was mentioned in the March number of the *Meteorological Magazine* that a change of policy with regard to the issue by the Meteorological Office of charts of the oceans for the use of sailors was contemplated. This change is now being made. Monthly charts of the North Atlantic and Indian Ocean, in which all information of a more permanent character have been prepared, are being issued in sets so that they may be available for reference in the chart room on board ship. The sets may be purchased through the Admiralty Chart Agents.

The Marine Observer

THE backs of the Meteorological Charts have been used hitherto for the circulation of information of interest to seamen. A much more convenient medium for this purpose has now been provided by the publication of a new magazine, *The Marine Observer*. The first number of the magazine was published on December 5th. Copies, price 2s. each, may be obtained from H.M. Stationery Office.

The Marine Superintendent, Commander Brooke Smith, is to be congratulated on this new development in the activity of the senior branch of the meteorological service.

A Defective Sunshine Recorder Ball

ON pages 76-77 of the *Book of Normals* the averages of the daily duration of bright sunshine at Broadstairs, Margate and Ramsgate are given as 4·79, 4·34 and 4·79 hours respectively. This seems to show that Margate receives nearly 30 minutes a day, or over 160 hours a year less sunshine than the neighbouring stations. Locally this difference was attributed to the loss of evening record at Margate owing to the sun setting in the haze at the mouth of the Thames, but the difference appeared to be increasing, and during the four years 1919 to 1922 Margate recorded an average of 206 hours a year less than Broadstairs, while on the occasion of the solar eclipse of April 8th, 1921, the gap in the record was greater at Margate than at any other station in the British Isles. Accordingly a second sunshine recorder was sent to Margate in May of this year to test the accuracy of the old instrument, and it was found that during June and July the new recorder, exposed side by side with the old one, registered 64.8 hours more sunshine, equivalent to 1.06 hours a day, and to fourteen per cent. of the total sunshine. Thus it appears, as we should expect from the proximity of the stations, that the differences in the real duration of sunshine

are small, but the old instrument at Margate has failed to register sunshine of slight burning power such as occurs near sunrise and sunset. The Meteorological Office inspector reported that the ball of the recorder (which was installed in 1892) is a deep yellow colour, and there is no doubt that, owing to some chemical or physical change, the glass has lost part of its transparency. A similar loss of sunshine, but to a far less extent, had previously been noticed at Lancaster and Hull, and investigation will be necessary to find out if any other stations are affected in this way.

Photography as a Scientific Implement

A "COLLECTIVE WORK" bearing the title *Photography as a Scientific Implement*, has been published by Messrs. Blackie & Son, Limited. The book has been written by thirteen specialists. The chapters vary in interest; some, like the first, on the history of photography, by C. R. Gibson, and the last, on the camera as witness and detective, by W. M. Webb, are easy and amusing, others are highly technical. There seems to be no direct reference to meteorology in the book, but the problems with which it deals are so closely akin to ours that we can say with confidence that it should be included in the equipment of the laboratory of every enterprising meteorological observatory.

Methods of Interpolation

THE needs of the Mathematical Laboratory established by Professor E. T. Whittaker at Edinburgh have already provided a stimulus for the writing of several useful text-books. A new one, "A short course in Interpolation," written by Professor Whittaker and Mr. George Robinson, has been published by Blackie & Son, Limited.

The book provides for much excellent training in arithmetical methods of interpolation, but we regret to notice that the importance of graphical methods is entirely overlooked. This defect stands out in the only question in the book with a direct bearing on meteorology. The heights above sea level corresponding with barometric pressures, 30, 27, 25, 23 and 20 inches are given, and the height corresponding with 29 inches is required. The practical method in such a case would be to plot the data on semilogarithmic paper and draw a more or less smooth curve, the possibility of angles corresponding with irregularities of temperature being borne in mind. The authors propose a method equivalent to using ordinary plotting paper and drawing the best fitting curve of the 4th degree. It is announced that this book is part of a larger work on the Calculus of Observations. We would like to see a chapter on meteorological applications in such a work.

Rime as an Indicator of Air Movements

THE fog which occurred near the end of November was remarkable in some parts of London for the development of rime. There was hardly any hoarfrost on the ground but objects exposed to the wind bore a fine crop of rime. One detail which I have not seen mentioned previously was conspicuous on the railings in various places on Hampstead Heath during the afternoon of Sunday, November 25th.

In the case of a horizontal iron rail one or two inches in diameter there would be a well defined horizontal central line, looking black in contrast with the white deposit above and below it. The central line was almost free from deposit and presumably marked the dead space between the part of the air which was deflected upwards and that which was deflected downwards. This evidence that, on the up-wind side at any rate, the airflow which carries the deposit is along steady stream lines rather than in shifting eddies is valuable. A series of photographs illustrating the formation of rime on various objects would be of great interest.

F.J.W.W.

Reviews

Medical Climatology of England and Wales. By Edgar Hawkins, M.A.(Oxon.), M.D.(Edin.), D.P.H.(Oxford). Demy 8vo., $8\frac{3}{4} \times 5\frac{1}{2}$, pp. xiv. + 302, 149 charts. London: H. K. Lewis & Co., Ltd. 1923. £1 5*s. net.*

In this book the author has succeeded in presenting facts about the Climatology of England and Wales in a manner designed to facilitate easy comparison between different stations and districts, specially for the purpose of the patient or doctor who wishes to discover a suitable climate for the treatment of a given ailment. In this presentation extensive use has been made of coloured diagrams, all of which are drawn on a uniform plan. There are 144 diagrams in the book, and, as everyone of these is purely climatological, it will be appreciated that considerable attention has been paid to the climatological aspect of the subject. There is not, in the whole book, a single full climatological table; the author clearly prefers the graphical to the statistical method of presentation. The diagrams, which are at once novel and ingenious, and convey a large amount of information in a striking manner, are of three main types.

In the first place there are charts showing by means of coloured block columns annual mean percentage values of temperature, sunshine, rainfall, daily range of temperature, cloud and relative humidity; showing further, by means of wind roses, the relative frequency of the three most prevalent wind directions, and by

block columns the average percentage numbers of days of snow, hail, thunderstorm, fog, gale and rain. Diagrams of this kind are given for each of the seven meteorological districts and also for a number of stations in each district. The block columns are all drawn to a common percentage scale, on which 100 represents* the normal annual value for the whole of England and Wales. It is, therefore, seen at a glance whether a particular element in a given district or at a given station is above or below the normal for the whole country, and what percentage of that normal the departure may be.

In the second place mean monthly values of temperature, daily range of temperature, sunshine, rainfall, rain-days, relative humidity and cloud are shown for the whole country and also for each district. These are line diagrams of the usual kind.

Thirdly, mean monthly values of temperature, daily range of temperature, rainfall and rain-days, expressed as percentages of the general means for England and Wales, are drawn for each district and for each station in each district. These are line diagrams with a common percentage scale, 100 representing the normal value for the month for the whole of England and Wales.

The percentage diagrams, especially the last described, are of a kind which is not generally familiar, and consequently they present unusual features. For example, the seasonal rainfall curve for Geldeston, Norfolk, shows a maximum (10 per cent. below the general mean) in July, and a minimum (about 35 per cent. below the general mean) in January. This does not necessarily mean that the January rainfall at Geldeston is less than the July fall, only that, in comparison with the country as a whole, Geldeston has a rather low rainfall for July and a decidedly low rainfall for January. Yet that is a fact of much importance to a patient seeking relief from wet winters, but compelled to remain in England. On the other hand, at Plymouth the rainfall in June is about equal to the general mean for June (99 per cent.), while in December it is as much as 60 per cent. above the general value for December.

The text contains general remarks on the climatology and soils of the country, with a discussion of their bearing on therapeutics, followed by detailed descriptions of the climatology and soils of various towns and districts with special reference to established health resorts.

We commend the book, not only to the medical man and the invalid, but also to the student of our English climate. It should be used to supplement other sources of information. To extract numerical data with no other book of reference available is not always an easy matter.

R.C.

* In the case of temperature, 0 is the freezing point and 100 is 48·2 F.

Het Klimaat Van Nederlandsch-Indie. By C. Braak. Koninklijk Magnetisch en Meteorologisch Observatorium te Batavia, Verh. No. 8, Vol. I., Part III. Size 11×8, pp. iv. +73 (Dutch) +39 (English Summary). *Illus.* Batavia, 1923.

THIS publication is the third part of a work on the climate of the Dutch East Indies. Part I. contains three introductory chapters; Part II. deals with wind and pressure; and the present publication, Part III., contains chapter (6) on rain. These three parts are all included in volume I., which is devoted to the general features of the climate of the Archipelago. In volume II. it is proposed to deal with the local climate of the different islands, while volume III. is to be devoted to climatological tables.

The islands are small enough to allow of an effective interchange of air with the surrounding seas, and as they are situated near the equator the rainfall is abundant. The influence of the continents of Asia and Australia renders the Archipelago "the most typical monsoon region of the world."

The amount of rainfall data in these islands is considerable, for Dr. W. Van Bemmelen, in his paper "On the Rainfall of Java,"* published records from 702 stations in Java alone with at least five years' observations in the period 1879 to 1905. The records have largely been maintained by private observers, as in this country. We are told, however, that of the material available "only a very moderate use has been made, the computation of the rain observations, which has already been started at the observatory, being reserved for a separate treatise." Chapter (6) contains no map of the average annual or monthly rainfall, the preparation of new maps being, however, in progress. Maps are given showing (*a*) month of greatest rainfall, (*b*) month of least rainfall, (*c*) number of months with 5 mms., or less in the dry year 1914, (*d*) number of consecutive months in which the average rainfall did not exceed 5, 10, 15, 30 and 50 mm. respectively in Java. Similar data for the rest of the Archipelago are embodied in a table.

With mountains which rise to over 10,000 feet, a feature of rainfall which is not met with in this country is described, namely, the falling off in the amount of rainfall at great heights after a maximum has been reached. Generally the level of the greatest amount of rain lies higher on the more elevated mountains. In the higher regions the rains lose more or less the character of tropical showers, and, in the place of short-lived thunderstorms, mist and drizzle become more frequent. Thus, the intensity of

* Maps of the average rainfall at Java for the year and for the periods December–February, March–April, May–June, July–September, and October–November were subsequently published in 1915.

rain decreases above a certain limit, but the longest duration of rain is found at the top of the mountain.

With this exception the amount of rainfall is found to be roughly proportional to the duration, or, in other words, the showers are of longer duration or more frequent at the stations with large rainfall than at the stations with small rainfall, but their intensity is about the same. A similar state of affairs is found in the British Isles, *e.g.*, the correlation coefficient between rainfall amount and duration for 48 records for the year 1915 is $+0{\cdot}80$ ($e=0{\cdot}04$).*

An analysis is made of the mean amount of rain falling in a rain-day at stations with different amounts of average monthly rainfall. The mean daily fall is considerably greater than that at stations in the British Isles with similar amounts of monthly rainfall. Nevertheless, the highest intensity of rain which has been recorded, namely, 3.8 mm. in a minute, is at a rate which has been exceeded in the British Isles on four definite occasions.

The variations from month to month, and also the variations during the day, are more complex, and are dealt with in some detail. The English Summary is sufficient to enable the tables of the Dutch text to be studied, and the whole volume makes interesting reading, as well as being of permanent value for future reference.

J.G.

News in Brief

It is officially reported that Flight Lieut. A. E. Gendle, the principal meteorological officer in the Middle East area was attacked by Arabs when walking near Baghdad with another officer on December 7th, and was killed on the spot. The other officer, Flight Lieut. Pearce, was severely wounded.

The Royal Society has appointed Mr. G. I. Taylor, F.R.S., to one of the first two Yarrow professors. The professorships have been founded through the generous gift made by Sir Arthur Yarrow and the holders are to devote their time to research. Much of Mr. Taylor's work is already regarded by meteorologists as classical and they will join in congratulating him on his appointment.

A joint conference of the Royal Meteorological Society, the Science Masters' Association, and the Geographical Association, will be held under the presidency of Sir Napier Shaw at Birkbeck College, London, on Thursday, January 3rd, at 2 p.m. The conference will discuss the place of meteorological observations in the school course and the teaching of meteorology and climatology in schools from the physical and the geographical standpoint. Visitors are invited.

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* See "*British Rainfall*," 1916, *p.* 37.

We learn with much regret that Sir Arthur Schuster has lost the sight of one of his eyes owing to an accident he met with a short time ago when he was accidentally struck by a golf club while standing near a lady player practising on his lawn. We understand that the doctor is satisfied with the progress he is making towards regaining his normal health.

Starting from January 1st, 1924, a new series of wireless weather reports especially intended for the use of seamen will be issued twice daily at 9h. and 20h. by the Meteorological Office through the Air Ministry wireless station. The code and full particulars may be found in the *Marine Observer*, in the Board of Trade notices to mariners for November, and in Supplement No. I. to the 2nd edition of *Particulars of Meteorological Reports* (M.O. 252), which will be published shortly by H.M. Stationery Office.

An address on recent developments in marine meteorology was delivered by Commander Brooke Smith at the Royal Technical College, Glasgow, on November 21st.

The *Amateur Wireless* states that a Biggleswade farmer has written to the British Broadcasting Co. informing them that he saved the cost of his four-valve set by listening-in to the weather forecasts. Hearing that rain was expected, he arranged to cart his crops one day before he originally intended.

The Weather of November, 1923

DURING the first two or three days of the month there was a continuance of the unsettled mild conditions of October, and maxima above 60° F. were registered, the actual highest reading, 65° F., being recorded at Cromer on the 3rd. Apart from these few days and two or three near the middle of the month, cold weather prevailed throughout November with much frost at night but many sunny days.

Northerly winds were experienced for some days in the rear of the depression, which passed northwards of Scotland towards Scandinavia on the 3rd, and these caused a gradual decrease in temperature until, on the night of the 7th-8th, screen minima as low as 18° F. were recorded at Tenbury, Marlborough and Rhayader. Snow and sleet were experienced in the north early in the month, and much rain or sleet occurred over the country generally as another depression passed southwards across the British Isles from Iceland to France. With the rise of pressure

in the north, the easterly winds strengthened to gale force in the Channel on the 10th.

From the 12th to 18th, a series of deep depressions caused heavy rain in all parts of the kingdom, and floods occurred in Lancashire, North Wales, Cheshire and other districts, causing much inconvenience and damage to property. The weather charts during this period followed a sequence which may be regarded as typical of unsettled "westerly" conditions. An anticyclone to westward of the British Isles caused warm air to flow towards Iceland on the 9th. Subsequently the equatorial current spread southward covering the British Isles by 13h. on the 12th, and raising the temperature to above 50° F. at most stations. Meanwhile, a cold northerly current had appeared in Iceland, where temperatures ranged from 19° F. to 25° F. The contrast of temperature was thus very marked, and the early appearance of a deep depression off north-west Ireland was not surprising. The disturbance moved north-eastward across the northern half of the kingdom during the 13th. Another depression followed a similar track on the 15th, and a third depression, pursuing a rather more northerly course, crossed Scotland during the night of the 16th-17th. After reaching the North Sea, the latter disturbance gradually filled up, moving slowly southwards, and a northerly current spreading over the British Isles terminated the series.

Gales and a good deal of rain accompanied all three disturbances. At Southport shortly after 12h on the 15th an unusually violent squall was experienced, the direction of the wind shifting from south-east to west with a force of 82 m.p.h. The rainfall was heaviest on the 12th and 13th, as much as 100 mm. (3·92 ins.) being recorded at Llyn Fawr (Glamorgan) on the 13th, 90 mm. (3·56 ins.) at Oughtershaw (Yorkshire) on the 12th, and 73 mm. (2·88 ins.) at Penrhyn Quarry (Carnarvon) on the 13th, while at Dungeon Ghyll (Westmoreland) the total was 153 mm. (6·02 ins.) for the 48 hours ending 9h on the 14th. The flooding appears to have been caused chiefly by rain falling during that period. According to the Liverpool correspondent of the "*Times*," writing on November 14th, the floods at Sale on the Mersey were the most severe within memory, the water being eleven feet deep at Sale Priory. At Clitheroe, 300 houses were flooded, and at Bury, fire engines had to be requisitioned to pump water out of houses. Rain is said to have fallen continuously for 48 hours at Portmadoc, and the streets were flooded to a depth of two feet.

After the 18th, showers of hail, sleet or snow fell repeatedly in the northern and western districts, and snow or sleet also occurred in London and the south-eastern counties on the 28th. The mean temperature for the last half of the month was well

below normal, and the readings of the screen minimum thermometer were exceptionally low, 12° F. being recorded at West Linton on the night of the 29th-30th, and at Rothamsted on the night 26th-27th, while a reading of 8° F. was registered above the surface of the snow by the terrestrial radiation thermometer at Balmoral on the 15th. Reference to Kew Observatory records shows that so prolonged a period of frost as that experienced between the 24th and 27th has not been experienced there in November since 1890. Aeroplane observations at South Farnborough show at 15,000 feet a mean temperature for the month 19° F. below the normal. Thunderstorms occurred at times during the month.

The early part of November was marked by great storminess in western Europe, and on the night of the 4th a very severe gale did much damage in Denmark and Slesvig Holstein. From the 10th to the 14th heavy rain in the south of the Rhone valley caused floods, and from the 22nd to the 28th there was a spell of very cold weather in Belgium, France and Italy, with heavy falls of snow which interfered with railway traffic, and caused a fatal motor omnibus accident in Italy. In the last eight or ten days of the month there was heavy rain in Spain, causing floods in Seville. Heavy rain in Italy, together with the melting of the snow which had fallen during the cold spell, resulted in floods in the valley of the Scalve in the Italian Alps which burst the dam holding up the artificial Gleno Lake. A wall of water, estimated at 90 feet deep, swept down the valley, doing enormous damage, while the loss of lives appears to have exceeded 300. About the 29th there was heavy rain in the hills near Aswân (Egypt), which flooded the Nile Railway and interrupted communications. From India it was reported on the 18th that very heavy rains had caused a breach in the east coast section of the Bengal-Nagpur railway. On the 20th a typhoon swept over the island of Luzon (Philippines), and the Visayas Islands, causing much damage. Manila was partly under water.

The special message from Brazil states that the rainfall in the north was slightly above the normal, in the centre slightly under the normal, and in the south still more scarce, the average being 45 mm. below normal. The weather was generally favourable for the crops except in the case of the sugar cane in the north. At Rio de Janeiro temperature was 25° F. below normal and pressure 4 mbs. above.

Rainfall November, 1923: General Distribution

England and Wales	99	per cent. of the average 1881-1915.
Scotland	110	
Ireland	97	
British Isles	101	

Rainfall Table for November, 1923

CO.	STATION.	In.	mm.	Per-cent. of Av	CO.	STATION.	In.	mm.	Per-cent. of Av.
Lond.	Camden Square.....	1·46	37	62	*War*	Birminghm, Edgbaston	1·80	46	76
Sur .	Reigate, Hartswood...	1·76	45	...	*Leics*	Leicester Town Hall...	1·77	45	...
Kent.	Tenterden, View Tower	2·34	59	77	,, .	Belvoir Castle.....	2·17	55	97
,, .	Folkestone, Boro. San.	2·13	54	...	*Rut* .	Ridlington.....	2·00	51	...
,, .	Broadstairs	2·27	58	92	*Linc.*	Boston, Skirbeck	2·41	61	121
,, .	Sevenoaks, Speldhurst.	2·17	55	...	,, .	Lincoln, Sessions House	1·98	50	105
Sus .	Patching Farm.....	1·93	49	54	,, .	Skegness, Estate Office.	2·43	62	113
,, .	Eastbourne, Wilm. Sq.	2·62	67	75	,, .	Louth, Westgate	3·61	92	140
,, .	Tottingworth Park....	2·45	62	66	,, .	Brigg	3·28	83	144
Hants	Totland Bay, Aston...	1·36	35	43	*Notts.*	Worksop, Hodsock....	2·30	59	117
,, .	Fordingbridge, Oaklnds	2·20	56	64	*Derby*	Mickleover, Clyde Ho..	2·47	63	111
,, .	Portsmouth, Vic. Park.	1·33	34	44	,, .	Buxton, Devon. Hos...	6·10	155	130
,, .	Ovington Rectory	2·39	61	72	*Ches.*	Runcorn, Weston Pt...	3·47	88	125
,, .	Grayshott	2·03	51	60	,, ..	Nantwich, Dorfold Hall	2·02	51	...
Berks	Wellington College...	1·93	49	75	*Lancs*	Bolton, Queen's Park .	6·25	159	...
,, .	Newbury, Greenham..	2·24	57	80	,, ..	Stonyhurst College....	7·99	203	177
Herts.	Bennington House....	...	...	...	,, ..	Southport, Hesketh...	4·79	122	153
Bucks	High Wycombe	1·76	45	71	,, ..	Lancaster, Strathspey.	6·13	156	...
Oxf..	Oxford, Mag. College..	1·20	31	54	*Yorks*	Sedbergh, Akay	10·35	263	199
Nor .	Pitsford, Sedgebrook..	1·72	44	78	,, .	Wath-upon-Dearne ...	2·49	63	122
,, .	Eye, Northolm.....	1·28	33	...	,, .	Bradford, Lister Pk...	4·77	121	163
Beds.	Woburn, Crawley Mill.	1·25	32	55	,, .	Oughtershaw Hall	10·10	257	...
Cam.	Cambridge, Bot. Gdns.	1·18	30	61	,, .	Wetherby, Ribston H..	2·72	69	116
Essex	Chelmsford, CountyLab	2·42	61	...	*ERY*	Hull, Pearson Park ...	3·06	78	140
,, .	Lexden, Hill House...	2·76	70	...	,, .	Holme-on-Spalding ...	2·37	60	...
Suff .	Hawkedon Rectory ...	2·09	53	92	,, .	Lowthorpe, The Elms.	3·11	79	127
,, .	Haughley House.....	2·21	56	...	*NRY*	West Witton, Ivy Ho..	5·68	144	...
Norf.	Beccles, Geldeston....	1·41	36	61	,, .	Pickering, Hungate ...	4·45	113	...
,,	Norwich, Eaton	3·27	83	127	,, .	Middlesbrough	3·79	96	179
,, .	Blakeney	3·18	81	143	,, .	Baldersdale, Hury Res.	...	...	...
,,	Swaffham	2·14	54	88	*Durh.*	Ushaw College	...	...	...
Wilts.	Devizes, Highclere....	1·93	49	...	*Nor* .	Newcastle, Town Moor.	4·31	109	178
Dor .	Evershot, Melbury Ho.	2·63	67	62	,, .	Bellingham Manor....	4·61	117	...
,, .	Weymouth, Westham..	...	...	...	,, .	Lilburn Tower Gdns...	5·05	128	...
,, .	Shaftesbury, Abbey Ho.	1·78	45	55	*Cumb*	Penrith, Newton Rigg..	...	...	...
Devon	Plymouth, The Hoe...	1·79	45	50	,, .	Carlisle, Scaleby Hall .	4·02	102	134
,, .	Polapit Tamar	4·91	125	116	,, .	Seathwaite	19·70	500	145
,, .	Ashburton, Druid Ho..	4·95	126	87	*Glam.*	Cardiff, Ely P. Stn.....	3·64	93	87
,, .	Cullompton	3·02	77	88	,, .	Treherbert, Tynywaun	8·81	224	...
,, .	Sidmouth, Sidmount ..	2·05	52	66	*Carm*	Carmarthen Friary....	5·60	142	112
,, .	Filleigh, Castle Hill ...	4·46	113	...	,, .	Llanwrda, Dolaucothy.	6·02	153	102
,, .	Hartland Abbey.....	4·74	120	...	*Pemb*	Haverfordwest, Portf'd	...	...	...
Corn.	Redruth, Trewirgie ...	4·82	123	99	*Card.*	Gogerddan.....	6·83	173	145
,, .	Penzance, Morrab Gdn.	4·54	115	99	,, .	Cardigan, County Sch. .	5·12	130	...
,, .	St. Austell, Trevarna..	4·51	115	92	*Brec* .	Crickhowell, Talymaes	6·75	171	...
Soms	Chewton Mendip	4·83	123	113	*Rad* .	Birm. W. W. Tyrmynydd	5·91	150	89
,, .	Street, Hind Hayes ...	2·17	55	...	*Mont.*	Lake Vyrnwy	6·34	161	114
Glos..	Clifton College	3·20	81	102	*Denb.*	Llangynhafal	3·61	92	...
,, .	Cirencester	2·14	54	70	*Mer* .	Dolgelly, Bryntirion..	7·74	197	125
Here.	Ross, County Obsy....	1·73	44	68	*Carn.*	Llandudno	4·94	126	160
,, .	Ledbury, Underdown.	1·36	35	56	,, .	Snowdon, L. Llydaw 9	21·50	546	...
Salop	Church Stretton.....	2·47	63	84	*Ang* .	Holyhead, Salt Island.	4·74	121	114
,, .	Shifnal, Hatton Grange	1·64	42	69	,, .	Lligwy	7·12	181	...
Staff.	Tean, The Heath Ho...	2·47	63	84	*Man.*	Douglas, Boro' Cem...	4·27	108	89
Worc.	Ombersley, Holt Lock.	1·23	31	54	*Guer.*	St. Peter Port, Grange.	5·34	136	127
,, .	Blockley, Upton Wold.	1·83	47	62	*Wigt.*	Stoneykirk, Ardwell Ho	4·43	113	111
War	Farnborough.....	2·37	60	86	,, .	Pt. William, Monreith .	4·98	127	...

Rainfall Table for November, 1923—*continued*

CO.	STATION.	In.	mm.	Per-cent. of Av	CO.	STATION.	In.	mm	Per-cent. of Av.
Kirk.	Carsphairn, Shiel.	10·12	257	...	*Caith*	Loch More, Achfary...	11·59	294	136
,, .	Dumfries, Cargen.....	5·55	141	123	,, ..	Wick	4·37	111	139
Dum	Drumlanrig	4·90	125	117	*Ork* .	Pomona, Deerness	6·16	157	157
Roxb	Branxholme	4·44	113	134	*Shet* .	Lerwick	7·43	189	175
Selk .	Ettrick Manse.....	6·17	157	...	*Cork.*	Caheragh Rectory	5·39	137	...
Berk.	Marchmont House	3·58	91	119	,, ..	Dunmanway Rectory.	4·40	112	71
Hadd	North Berwick Res....	2·32	59	104	,, ..	Ballinacurra	3·58	91	89
Midl	Edinburgh, Roy. Obs..	2·25	57	104	,, ..	Glanmire, Lota Lo. ...	3·62	92	84
Lan .	Biggar	3·70	94	130	*Kerry*	Valencia Obsy.	5·02	127	92
Ayr .	Kilmarnock, Agric. C..	3·92	99	104	,, .	Gearahameen	8·60	218	...
,, .	Girvan, Pinmore.....	6·96	177	131	,, .	Killarney Asylum.....	5·73	145	102
Renf.	Glasgow, Queen's Pk..	3·29	84	88	,, .	Darrynane Abbey	4·88	124	96
,, .	Greenock, Prospect H..	5·42	138	84	*Wat* .	Waterford, Brook Lo..	2·45	62	65
Bute.	Rothesay, Ardencraig.	5·42	137	107	*Tip* .	Nenagh, Cas. Lough...	3·84	97	96
,, .	Dougarie Lodge	4·35	111	...	,, .	Tipperary	3·89	99	...
Arg .	Glen Etive.....	7·54	191	...	,, .	Cashel, Ballinamona ..	4·17	106	119
,, .	Oban	6·08	154	...	*Lim* .	Foynes, Coolnanes	4·28	109	107
,, .	Poltalloch	...	...	...	,, .	Castleconnell Rec.	4·87	124	...
,, .	Inveraray Castle.....	...	...	...	*Clare*	Inagh, Mount Callan ..	7·42	189	...
,, .	Islay, Eallabus.....	7·49	190	139	,, .	Broadford, Hurdlest'n.	4·89	124	...
,, .	Mull, Benmore	12·70	323	...	*Wexf*	Newtownbarry.....	2·62	67	...
,, .	Mull, Quinish	...	...	...	,, .	Gorey, Courtown Ho...	2·87	73	82
Kinr.	Loch Leven Sluice	2·66	68	74	*Kilk.*	Kilkenny Castle	2·12	54	69
Perth	Loch Dhu	6·15	156	71	*Wic* .	Rathnew, Clonmannon	2·53	64	...
,, ..	Balquhidder, Stronvar.	5·35	136	67	*Cars.*	Hacketstown Rectory .	3·01	77	77
,, ..	Crieff, Strathearn Hyd.	2·24	57	52	*QCo.* .	Blandsfort House.....	1·91	49	57
,, ..	Blair Castle Gardens ..	3·46	88	...	,,	Mountmellick	2·81	71	...
,, .	Coupar Angus School..	2·16	55	77	*KCo.*	Birr Castle.....	2·96	75	95
Forf.	Dundee, E. Necropolis.	2·24	57	92	,, .	Ballycumber, Bellair..	2·75	70	...
,, .	Pearsie House.....	2·68	68	...	*Dubl.*	Dublin, FitzWm. Sq...	1·87	48	70
,, .	Montrose, Sunnyside..	3·19	81	120	,, .	Balbriggan, Ardgillan .	1·83	47	64
Aber.	Braemar Bank	3·33	85	86	*Me'th*	Drogheda, Mornington	2·14	54	...
,, .	Logie Coldstone Sch. ..	3·97	101	129	*W.M*	Mullingar, Belvedere .	2·54	65	74
,, .	Aberdeen, Cranford Ho	3·32	84	103	*Long*	Castle Forbes Gdns....	3·32	84	92
,, .	Fyvie Castle	4·92	125	...	*Gal* .	Galway, Waterdale ...	3·31	84	...
Mor .	Gordon Castle.....	5·23	133	182	*Mayo*	Crossmolina, Enniscoe	6·04	153	103
,,	Grantown-on-Spey....	2·87	73	96	,, .	Mallaranny.....	8·03	204	...
Na .	Nairn, Delnies.....	2·66	67	113	,, .	Westport House.....	5·30	135	108
Inv. .	Ben Alder Lodge	3·88	99	...	,, .	Delphi Lodge	11·02	280	...
,, .	Kingussie, The Birches	3·20	81	...	*Sligo*	Markree Obsy.	5·08	129	120
,, .	Fort Augustus	4·82	122	105	*Ferm*	Enniskillen, Portora ..	4·66	118	...
,, .	Loch Quoich, Loan....	13·00	330	...	*Arm.*	Armagh Obsy.	3·75	95	132
,, .	Glenquoich	10·16	258	84	*Down*	Warrenpoint	2·86	73	...
,, .	Inverness, Culduthel R.	2·51	64	...	,, .	Seaforde	3·80	97	100
,, .	Arisaig, Faire-na-Squir	8·02	204	...	,, .	Donaghadee	2·69	68	88
,, .	Fort William.....	6·59	167	82	,, .	Banbridge, Milltown .	2·62	67	95
,, .	Skye, Dunvegan.....	7·50	191	...	*Antr.*	Belfast, Cavehill Rd. ..	3·64	93	...
,, .	Barra, Castlebay	3·08	78	...	,, .	Glenarm Castle.....	3·63	92	...
R&C	Alness, Ardross Cas. ..	3·74	95	93	,, .	Ballymena, Harryville	3·79	96	94
,, .	Ullapool.....	6·30	160	...	*Lon* .	Londonderry, Creggan	5·70	145	139
,, .	Torridon, Bendamph..	9·26	235	100	*Tyr* .	Donaghmore	4·13	105	...
,, .	L. Carron, Plockton...	4·81	122	...	,, .	Omagh, Edenfel	5·28	134	139
,, .	Stornoway	7·29	185	125	*Don* .	Malin Head	4·01	102	122
Suth.	Dunrobin Castle.....	...	...	...	,, .	Letterkenny Hospital .	6·06	154	125
,, .	Lairg	4·68	119	...	,, .	Dunfanaghy	4·63	117	98
,, .	Tongue Manse.....	4·67	119	102	,, .	Narin, Kiltoorish	5·13	130	...
,, .	Melvich School.....	5·47	139	137	,, .	Killybegs, Rockmount.	8·02	204	127

Climatological Table for the British Empire, June, 1923

STATIONS	PRESSURE		TEMPERATURE							Relative Humidity	Mean Cloud Am'nt	PRECIPITATION			BRIGHT SUNSHINE	
			Absolute		Mean Values				Mean							
	Mean of Day M.S.L.	Diff. from Normal	Max.	Min.	Max.	Min.	½ max. and min.	Diff. from Normal	Wet Bulb.			Am'nt	Diff. from Normal	Days	Hours per day	Percentage of possible.
	mb.	mb.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	%	0—10	mm.	mm.			
London, Kew Obsy.	1021·1	+ 4·4	75	37	62·9	48·8	55·9	− 3·3	51·8	72	8·1	6	− 49	7	3·9	24
Gibraltar	1018·4	+ 2·6	80	54	72·8	60·3	66·5	− 3·8	61·1	74	4·2	33	+ 21	5	...	...
Malta	1015·5	+ 0·9	91	61	75·2	64·8	70·0	− 2·0	63·1	69	4·1	1	− 1	1	...	...
Sierra Leone	1013·4	+ 0·7	89	69	86·7	73·6	80·1	− 0·4	75·9	78	7·2	337	−153	22	...	...
Lagos, Nigeria	1012·5	− 0·4	89	70	85·3	74·4	79·9	+ 1·3	76·3	82	8·3	637	+154	23	...	...
Kaduna, Nigeria	1014·0	+ 0·2	90	62	86·7	67·9	77·3	+ 1·3	71·1	75	...	183	− 42	16	...	...
Zomba, Nyasaland	1017·6	+ 0·2	79	49	74·7	53·5	64·1	+ 1·6	...	81	3·7	2	− 13	2	...	...
Salisbury, Rhodesia	1019·3	− 0·9	85	36	73·1	41·6	57·3	+ 0·9	52·0	65	1·5	0	− 1	0	...	...
Cape Town	1018·0	− 2·3	72	39	61·2	49·7	55·5	− 0·3	53·2	82	6·0	139	+ 26	13	...	...
Johannesburg	1022·9	− 1·5	63	28	59·1	39·7	49·4	− 1·3	39·0	59	2·5	12	+ 9	1	9·1	87
Mauritius	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Bloemfontein	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Calcutta, Alipore Obsy.	997·5	− 2·2	108	75	95·5	80·5	88·0	+ 2·9	80·4	79	8·4	136	−154	*8	...	...
Bombay	1004·9	+ 0·7	94	76	90·7	81·7	86·2	+ 2·3	78·9	77	6·4	183	−286	*7	...	...
Madras	1002·9	− 0·9	110	77	102·6	82·2	92·4	+ 2·5	76·4	52	4·8	50	+ 2	*2	...	...
Colombo, Ceylon	1012·4	+ 4·1	87	73	85·0	77·4	81·2	− 0·7	77·4	77	9·4	202	+ 10	24	4·4	35
Hong Kong	1004·8	− 1·3	91	71	84·6	77·6	81·1	− 0·4	76·6	82	8·2	399	+ 1	24	5·1	38
Sandakan	...	...	91	72	89·2	75·4	82·3	+ 0·6	76·9†	77†	...	341	+156	16	...	...
Sydney	1010·9	− 7·0	80	43	64·9	50·0	57·5	+ 3·1	51·4	65	5·1	96	− 31	6	4·8	48
Melbourne	1010·2	− 8·3	66	37	57·6	47·1	52·3	+ 1·9	49·2	76	7·5	58	+ 5	19	2·7	28
Adelaide	1011·2	− 7·9	70	43	60·3	48·6	54·5	+ 1·1	50·5	76	7·3	147	+ 69	23	2·7	28
Perth, W. Australia	1011·2	− 6·8	69	42	62·4	49·9	56·1	− 0·5	52·1	75	6·7	325	+153	21	4·2	42
Coolgardie	1012·4	− 6·7	67	32	58·7	43·5	51·1	− 1·6	48·7	69	6·7	78	+ 47	19	...	...
Brisbane	1014·5	− 3·5	82	42	70·6	50·8	60·7	+ 0·6	55·8	62	2·6	68	+ 3	3	8·5	81
Hobart, Tasmania	1007·4	− 6·9	60	35	52·8	42·2	47·5	+ 0·7	44·7	80	7·0	89	+ 33	16	3·1	34
Wellington, N.Z.	1004·5	− 9·8	62	32	55·1	41·5	48·3	− 1·4	45·2	79	6·1	86	− 35	12	4·1	45
Suva, Fiji	1013·1	− 0·5	81	60	77·9	66·5	72·2	− 2·7	68·2	84	5·3	207	+ 51	15	...	...
Kingston, Jamaica	1014·1	+ 0·1	93	71	89·4	73·7	81·5	+ 0·2	...	66	4·4	5	−100	4	...	...
Grenada, W.I.	1015·2	+ 1·9	88	72	84·4	74·6	79·5	+ 0·7	74·5	75	6·5	93	−126	22	...	...
Toronto	1012·3	− 2·0	96	44	77·0	56·1	66·5	+ 3·9	60·5	72	4·0	108	+ 38	12	...	...
Winnipeg	1011·3	− 1·2	93	41	80·7	54·5	67·6	+ 5·4	61·3	62	3·0	37	− 46	5	...	...
St. John, N.B.	1008·6	− 5·4	71	43	63·4	46·4	54·9	− 1·6	50·1	76	7·0	50	− 33	10	...	...
Victoria, B.C.	1013·7	− 3·2	86	47	65·0	49·6	57·3	+ 0·3	52·4	77	5·0	10	− 14	5	...	...

* For Indian stations a rain day is a day on which 0·1 in. (2·5 mm.) or more rain has fallen. † Mean of observations at 9h., 15h., 21h., from April, 1923.